

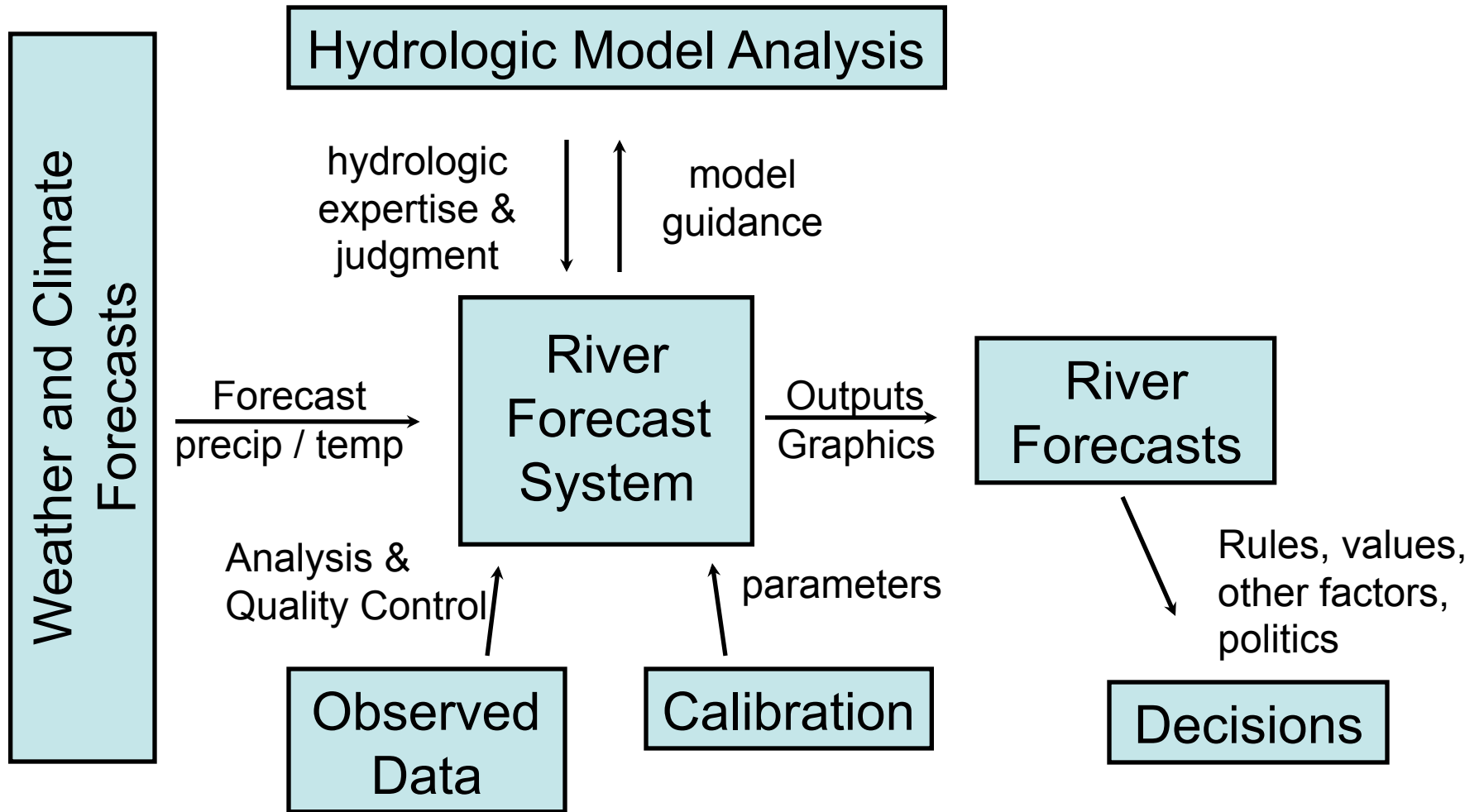
Decision Support

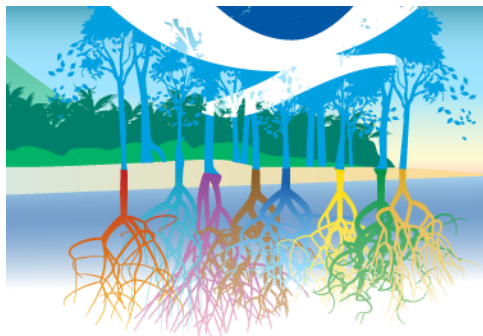
CBRFC
Stakeholder Workshop

Kevin Werner
Service Coordination Hydrologist
Colorado Basin RFC

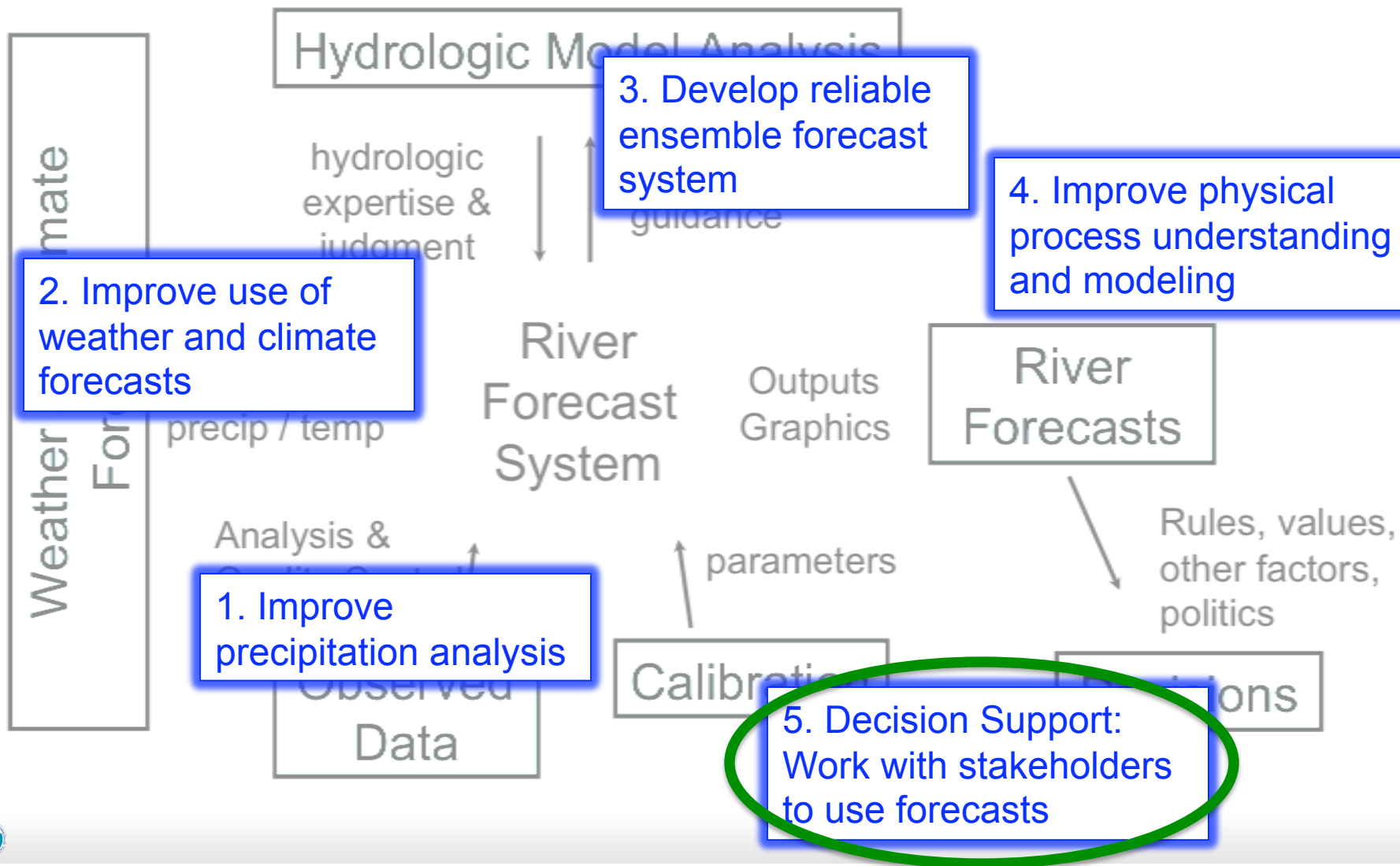


Forecast Process





CBRFC Research Needs





Previous Research on decision support in the water sector

Forecasts generally not used. Water management agencies value reliability and quality above all else. Unless those are threatened, agencies have little incentive to use forecasts.

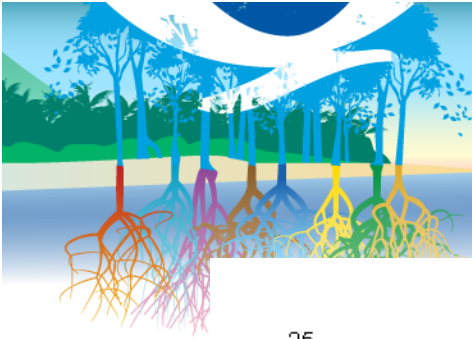
Forecast use correlates with perceived risk. Forecast usage not dependent on agency size or on understanding of forecast skill and reliability.

Policy and infrastructure in USA limit use of forecasts. Many operating decisions are tied to observed data and do not allow flexibility.

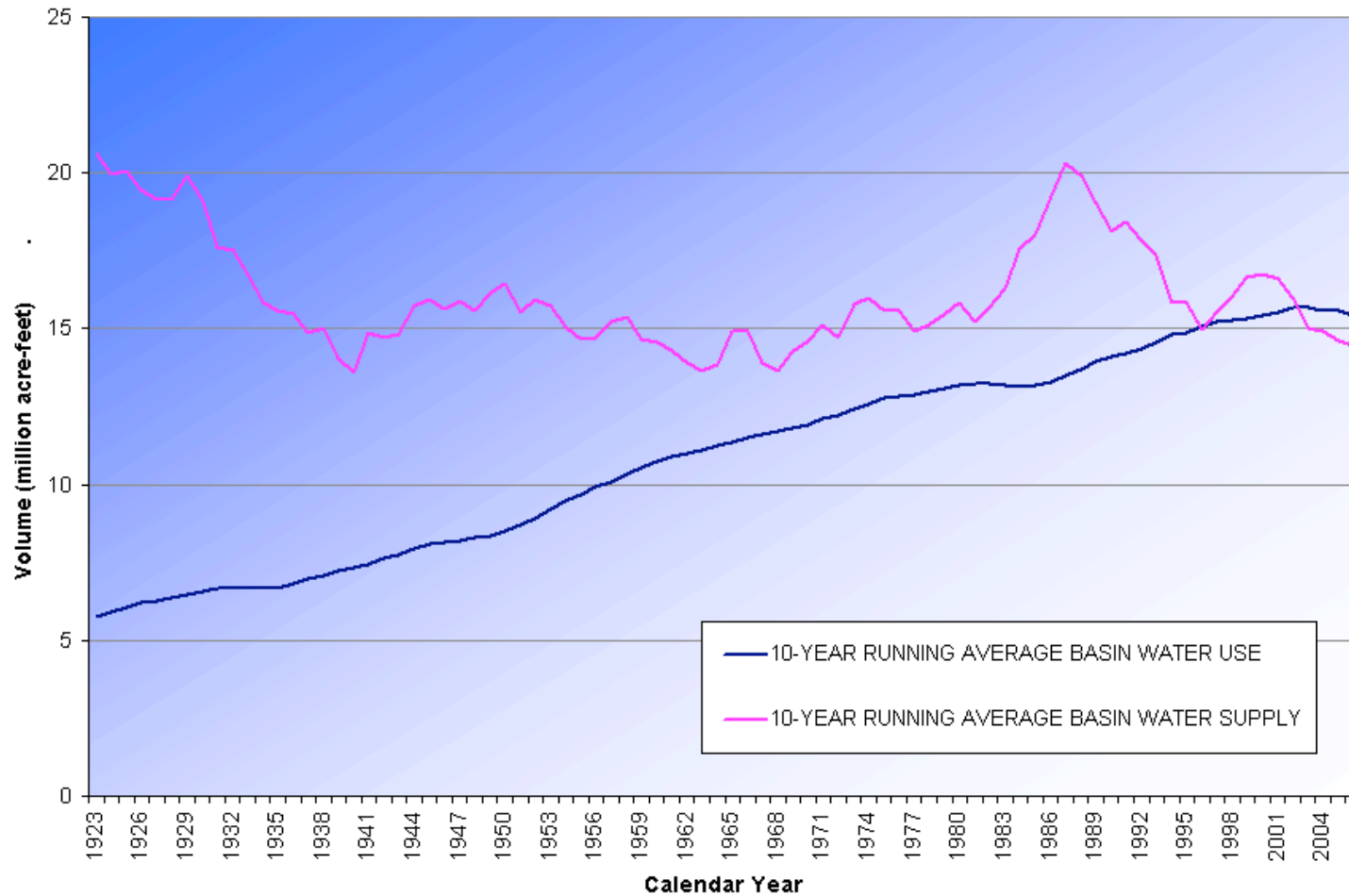
Hopeless?

No! Long term drought, increasing demands, and climate change projections for less water each present opportunities for increasing forecast usage.

Study	Method(s)	Geographic Area(s)
(Rayner et al., 2005)	Field Research: Semi-structured Interviews	USA: Pacific Northwest, Southern California, and Washington, DC
(O'Connor et al., 2005)	Survey	USA: South Carolina and Susquehanna River Basin of Pennsylvania
(Lemos, 2008)	Field Research: Observation of Meetings	USA and Brazil
(Dow et al., 2007)	Survey (building on earlier work (O'Connor et al., 2005))	USA: South Carolina and Susquehanna River Basin of Pennsylvania
(Callahan & Miles, 1999)	Field Research: Semi-structured interviews	USA: Pacific Northwest
(Ziervogel et al., 2010)	Case Study	South Africa
(Pulwarty & Redmond, 1997)	Field Research: Semi-structured interviews	USA: Pacific Northwest



Colorado River Supply and Demand

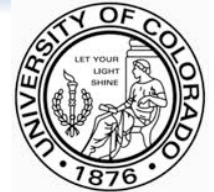


Credit: USBR

CBRFC Partnerships



THE METROPOLITAN WATER DISTRICT
of SOUTHERN CALIFORNIA



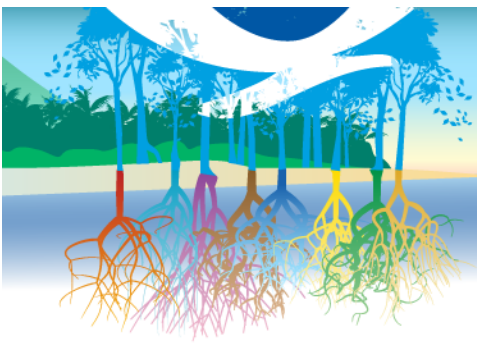
Western Water Assessment



CAP
CENTRAL ARIZONA PROJECT



Example: Denver Water Application



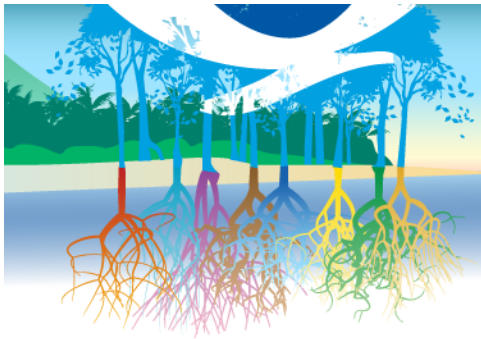
RFC ESP Forecasts

Reservoir Management

Results of Dillon ESP Simulations																	
Date of Traces: 4/7/08																	
Note: When elevations correspond to a specific date, the elevation occurs at the end of that date.																	
From May 26 - September 3.																	
Trace	Elev < 9002	Elev > 9002	# Days < 9002	Elev = 9011	Elev = 9017	Elev May 26	Elev June 30	Peak Comp Inflow	Peak Outflow	Days <450 out	Days 450-699	Days 700-1199	Days 1200-1399	Days >= 1400 out			
Date	Date	Date	Date	Date	Date			cfs	Date	cfs	Date						
1976	n/a	n/a	0	6/2	6/8	9006.60	9017.99	2266	6/6	1747	6/13	0	71	19	7	4	
1977	n/a	n/a	0	5/24	6/4	9011.70	9017.23	1990	6/6	1432	6/9	0	83	11	4	3	
1978	5/10	5/23	14	6/12	6/18	9002.70	9018.20	2539	6/15	1591	6/24	0	76	16	4	5	
1979	5/12	5/20	9	6/6	6/13	9004.30	9018.60	2735	6/15	2173	6/18	0	69	12	2	18	
1980	n/a	n/a	0	6/9	6/16	9004.40	9017.94	2226	6/12	1321	6/22	0	79	17	5	0	
1981	n/a	n/a	0	6/2	6/8	9006.80	9017.82	2857	6/9	2219	6/13	0	66	21	6	8	
1982	5/14	5/28	15	6/17	6/25	9001.10	9018.73	2033	6/18	1702	7/2	0	79	13	3	6	
1983	5/10	6/9	31	6/20	6/23	8999.00	9019.29	3384	6/24	2781	6/28	0	55	25	2	19	
1984	5/7	5/20	14	5/31	6/8	9006.10	9018.55	2549	6/15	2311	6/17	0	55	20	4	22	
1985	n/a	n/a	0	6/2	6/8	9006.30	9017.83	2877	6/9	1935	6/12	0	71	16	4	10	
1986	n/a	n/a	0	6/5	6/13	9005.70	9017.90	2349	6/9	1515	6/19	0	75	17	6	3	
1987	n/a	n/a	0	5/25	6/8	9011.10	9017.88	2107	6/8	1331	6/16	0	76	19	6	0	
1988	5/11	5/16	6	6/8	6/15	9003.80	9018.15	2357	6/9	1875	6/21	0	76	13	3	9	
1989	n/a	n/a	0	5/29	6/9	9008.80	9017.70	1912	5/30	1331	6/22	0	76	19	6	0	
1990	5/13	5/23	11	6/7	6/12	9002.80	9018.17	2926	6/10	1971	6/16	0	71	15	3	12	
1991	5/8	5/19	12	6/3	6/10	9005.40	9018.10	2395	6/12	1969	6/15	0	71	15	3	12	
1992	n/a	n/a	0	5/18	5/27	9016.20	9017.81	1875	5/21	1391	6/14	0	60	32	9	0	
1993	5/11	5/15	5	6/3	6/12	9005.10	9018.40	2789	6/18	2404	6/19	0	69	10	7	15	
1994	n/a	n/a	0	6/2	6/8	9006.50	9017.62	2241	6/7	1442	6/16	0	77	14	7	3	
1995	5/8	6/10	34	4/8	6/21	9000.00	9019.96	3843	7/9	3613	7/10	0	48	18	3	32	
1996	n/a	n/a	0	5/24	6/3	9012.60	9017.91	2273	5/25	1840	6/11	0	68	16	5	12	
1997	5/13	5/16	4	6/5	6/12	9004.30	9018.52	2535	6/19	2311	6/23	0	69	11	4	17	
1998	n/a	n/a	0	6/2	6/13	9005.40	9017.89	2122	6/3	1054	6/24	0	72	29	0	0	
1999	5/12	5/23	12	6/6	6/12	9003.70	9019.05	2854	6/21	2559	6/22	0	56	19	2	24	
2000	n/a	n/a	0	5/22	5/28	9014.60	9017.46	2736	5/31	2334	6/2	0	72	14	3	12	
2001	n/a	n/a	0	5/25	6/1	9011.40	9017.64	2292	6/3	1759	6/5	0	70	17	3	11	
2002	n/a	n/a	0	5/31	6/8	9006.20	9017.24	2465	6/1	1169	6/13	0	87	14	0	0	
2003	5/11	5/21	11	5/30	6/3	9005.10	9018.26	3180	5/31	2139	6/19	0	62	13	6	20	
2004	n/a	n/a	0	5/27	6/6	9010.40	9017.52	1836	6/8	1311	6/11	0	85	13	3	0	
2005	5/12	5/20	9	6/29	6/8	9007.80	9017.89	2074	5/24	1679	6/21	0	72	18	4	7	
37	Min	5/7	5/15	0	4/8	5/27	8999.00	9017.23	1836	5/21	1054	6/2	0	48	10	0	0
38	Max	5/14	6/10	34	6/20	6/25	9016.20	9019.96	3843	7/9	3613	7/10	0	87	32	9	32
39	Avg	5/10	5/23	6	5/31	6/9	9006.53	9018.11	2487	6/9	1873	6/17	0	71	17	4	9
41	90% Ex	8-May	16-May	0	5/23	6/2	9002.54	9017.51	1983	5/29	1320	6/10	0	56	12	2	0
42	70% Ex	10-May	19-May	0	5/29	6/8	9004.37	9017.83	2236	6/5	1493	6/13	0	69	14	3	3
43	50% Ex	11-May	20-May	0	6/2	6/8	9005.90	9017.93	2376	6/9	1799	6/17	0	71	16	4	9
44	30% Ex	12-May	23-May	10	6/9	6/12	9007.10	9018.22	2736	6/12	2149	6/21	0	76	18	5	12
45	10% Ex	13-May	5-Jun	14	6/9	6/18	9011.79	9018.76	2951	6/19	2420	6/24	0	79	21	7	20
47	Assumed RT off until June 1 and April "normal" operating plan thereafter. Took HT from April "normal" plan.																
48	Assumed Fernandez' suggestion and then held the 470 release.																
50	Raffable flows approx 450 - 1800 cfs. Optimum for commercial approx 700 - 1400 cfs.																
51	Good stream fishing approx 450 cfs and below. Marginal fishing 450 - 700 cfs.																



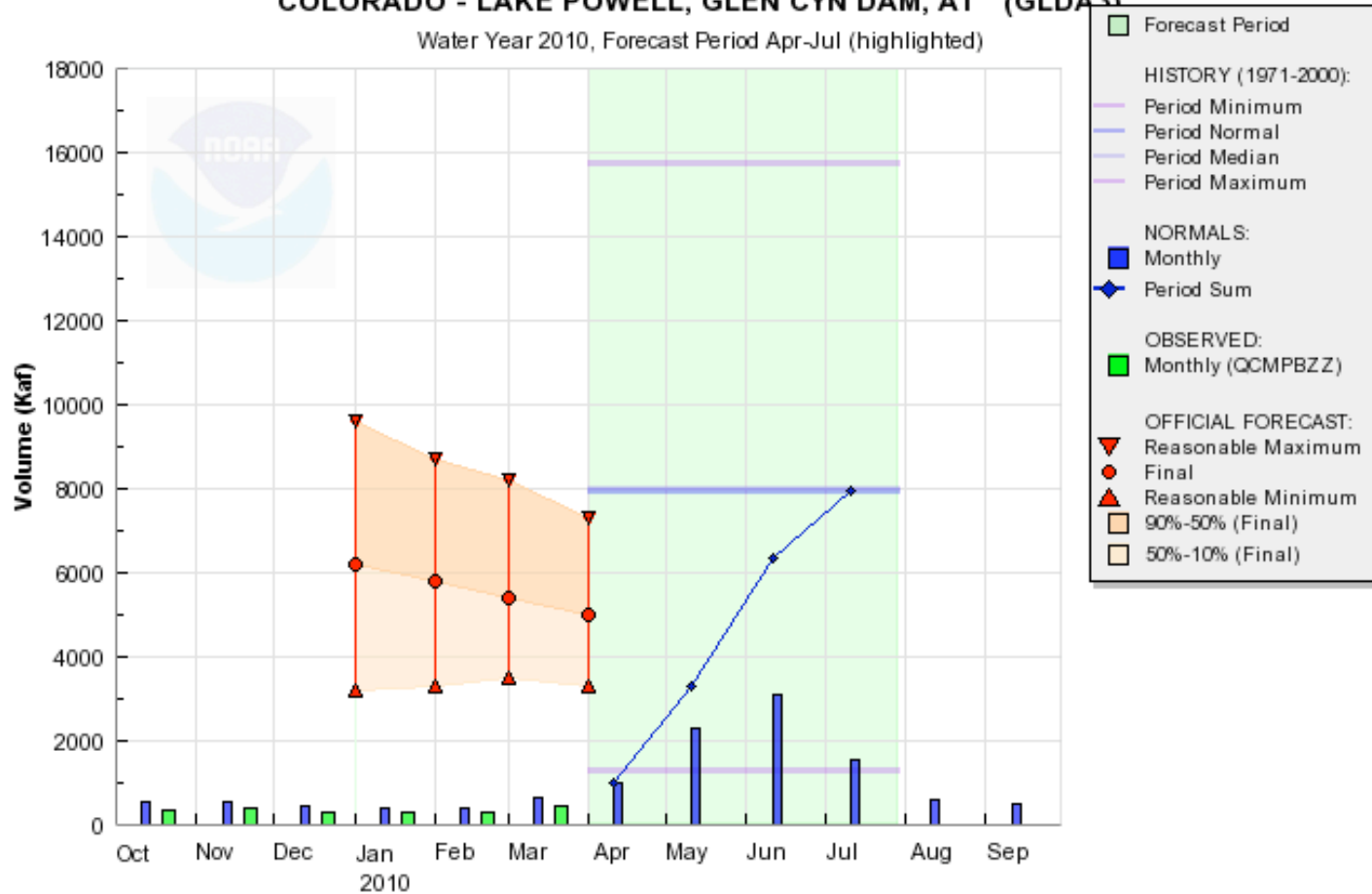
Credit: Bob Steger, Denver Water



Example: Lake Powell Forecast

COLORADO - LAKE POWELL, GLEN CYN DAM, AT (GLDA3)

Water Year 2010, Forecast Period Apr-Jul (highlighted)



CBRFC/NWS/NOAA 04/16/10 15:36:55 UTC





Lake Powell Probability of Equalization Forecast

Background:

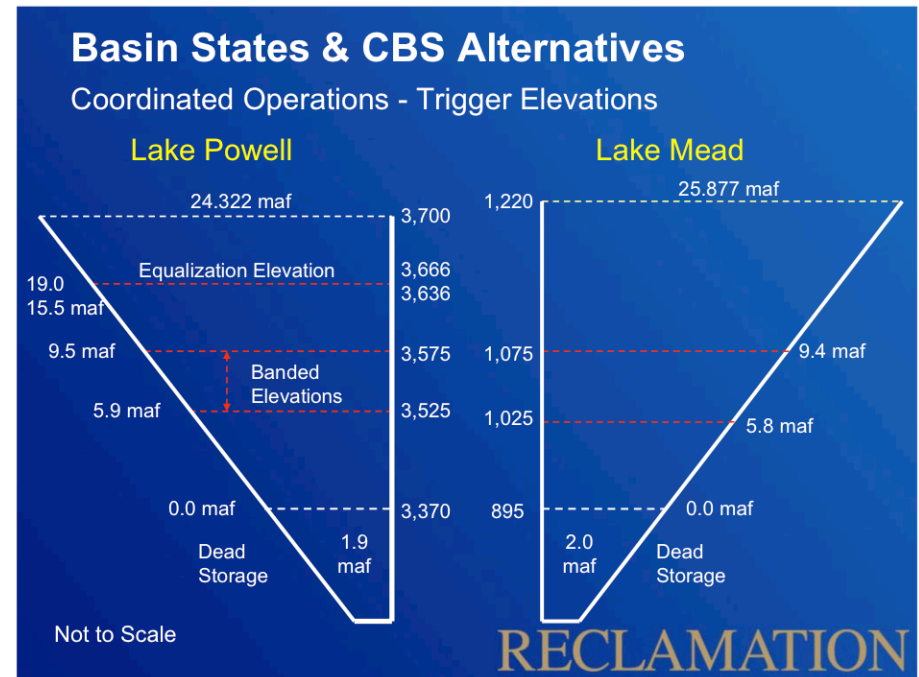
Drought conditions in the Colorado Basin severely stressed water supplies

In 2007, the USBR in consultation with the seven basin states adopted an interim operating agreement in affect until 2026 that defines how water shortages and surplus will be allocated to the basin states.

Allocations are determined by lake elevation triggers. In many cases, these triggers are based on forecasts.

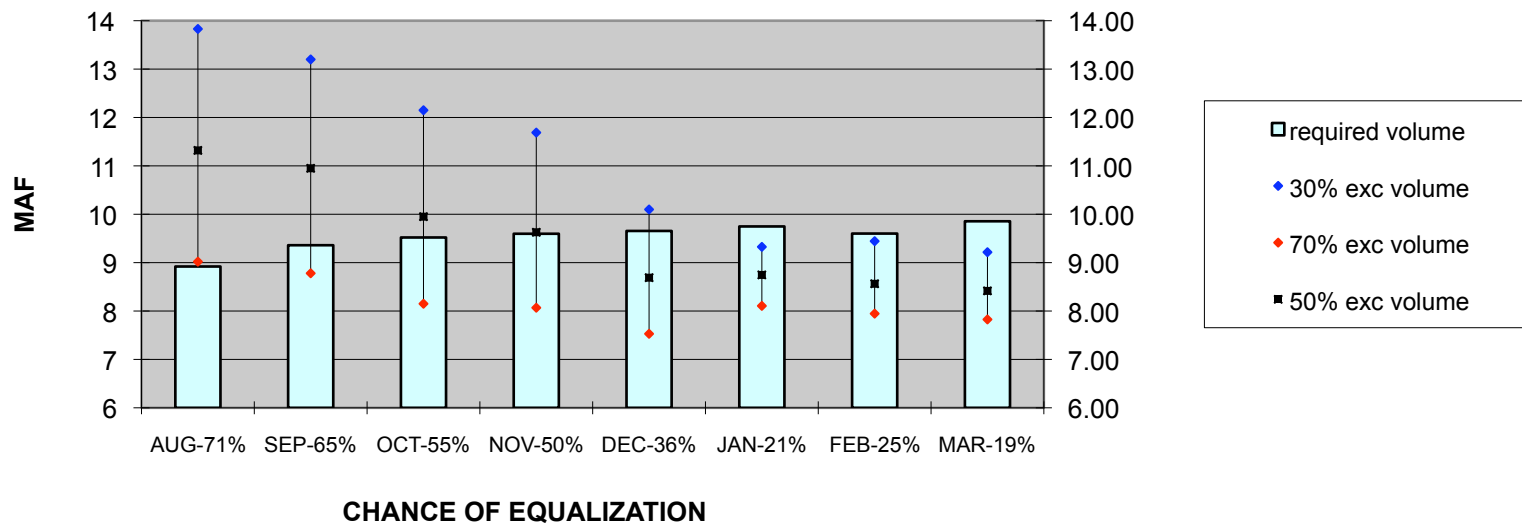
Stakeholders requested forecasts for probabilities of triggering various actions.

In 2009, CBRFC and USBR developed a forecast of the chance that Lake Powell will reach the equalization level by the end of the water year. Somewhat different from the chance that April 1 forecast will forecast the same.



LAKE POWELL FORECAST PROBABILITY DISTRIBUTION OBSERVED INFLOW VOLUME WATER YEAR 2010

•After October the water year to date observed volume is include in all numbers



This is the forecast of the chance that Lake Powell will reach the equalization level by the end of the water year – not the chance that equalization will be triggered.



Toolkit for User Engagement

Previous efforts:

- Forecast verification – Large workshop in Boulder, CO in 2008 with hands on lab exercises and presentations (collaboration with WWA)
- Soil moisture – Focus group workshop in Tucson, AZ in 2009 with specific questions and social science techniques (collaboration with CLIMAS)

Goal: Develop a systematic workshop to gauge forecast usage, potential usage, and

Engaged with WWA (Kristen Averyt) and CLIMAS (Gigi Owen) to develop toolkit

Dry run at CBRFC in March 2010

First toolkit workshop April 2010 in Grand Junction, CO

Follow on workshops in Utah and SE USA.

April 23, 2010: Grand Junction, CO

Introduce and evaluate the new national Water Resource Outlook web-based tool developed by the CBRFC

- **Climate Literacy and Information Use Survey**
 - (Pre- and Post-Workshop)
- **Computer-based usability evaluation**
- **Scenario Exercises**
 - Used to evaluate how the tool might be used & what information people use to make decisions

WWA Funding: July 2009–onward
Leveraged Funding: NOAA NWS
CBRFC



Working with NOAA West...

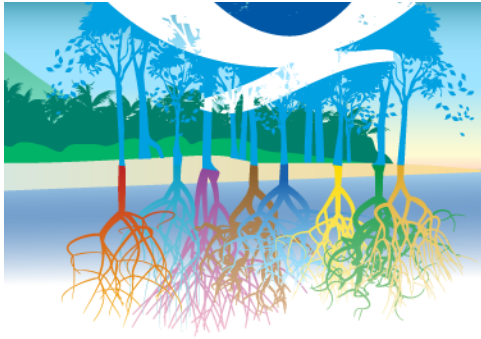
Deliver a broader suite of improved water services to support management of the Nation's Water Supply





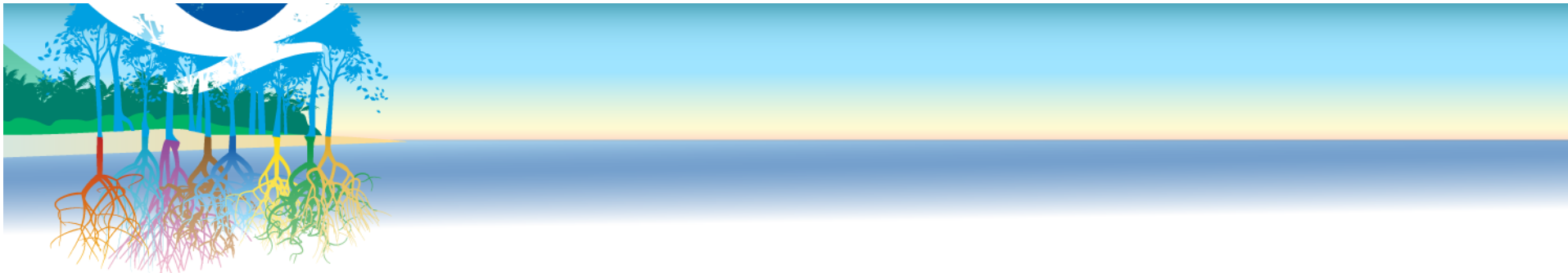
Summary

- ☑ RFCs develop and maintain a real time hydrologic modeling and forecasting environment to support water related decisions nation wide
- ☑ RFCs are looking more to provide water resources decision support
- ☑ We're looking to work with groups like yours to develop these concepts and prototype services



Wrap up from this meeting

☑ Action Items....



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